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## The Non-Fisheries Biological Resources of the Hanford Reach of the Columbia River<sup>1</sup>



### Abstract

The Hanford Reach is the only undammed segment of the Columbia River in the United States upstream from Bonneville Dam. The non-agricultural and non-recreational land-use policies imposed by the Department of Energy have permitted the Hanford Site to function as a refugium for wildlife for 35 years. The protection offered by the Hanford Site has been especially important for the Bald Eagle (*Haliaeetus leurocephalus*), mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), and resident Great Basin Canada Goose (*Branta canadensis moffitti*). Island habitats are especially important for nesting geese and for mule deer fawning. Coyotes are important predators upon nesting geese and mule deer fawns. Salmon carcasses are an important winter food for Bald Eagles.

Riparian plant communities along the Columbia River have been changing in response to changing water level fluctuations largely regulated by power generation schedules at upstream hydroelectric dams. There are no studies presently established to record the response of Columbia River shoreline plant communities to these kinds of fluctuating water levels.

The existing information is summarized on birds and mammals closely allied with the Hanford Reach of the Columbia River. High trophic level wild animals are discussed as indicators of chemical contamination of food chains.

### Introduction

The Hanford Reach of the Columbia River extends upstream from the city of Richland, Washington, to Priest Rapids Dam, a distance of about 90 km (Fig. 1). The western bank of the river lies mostly within the boundaries of the U.S. Department of Energy's Hanford Site; the eastern bank is mostly privately owned land downstream from Ringold Springs. The land within the boundaries of the Hanford Site is largely undeveloped; in general, private land supports irrigated crops at places where soil conditions are favorable.

Immediately after the establishment of the Hanford Site in 1943, the Columbia River between Priest Rapids and Richland was closed to public use. Strict control was maintained until the late 1960s when the river was opened for public boating upstream to the abandoned townsite at Hanford (Fig. 1). In 1978, the entire Reach of the Columbia was opened to public boating use.

Because of long-standing restrictions to public use, the Hanford Site has acted as a refugium for wildlife in a region that is otherwise being steadily converted from sagebrush-grass ecosystems to irrigated crops. The Columbia River adjacent to the Hanford Site is the only free-flowing segment of that river in the United States upstream from Bonneville Dam. The remainder of the river is slack water created by a series of dams extending from Bonneville upstream to Grand Coulee.

<sup>1</sup>Work performed for the U.S. Department of Energy under Contract DE-ACO6-76RLO 1830.

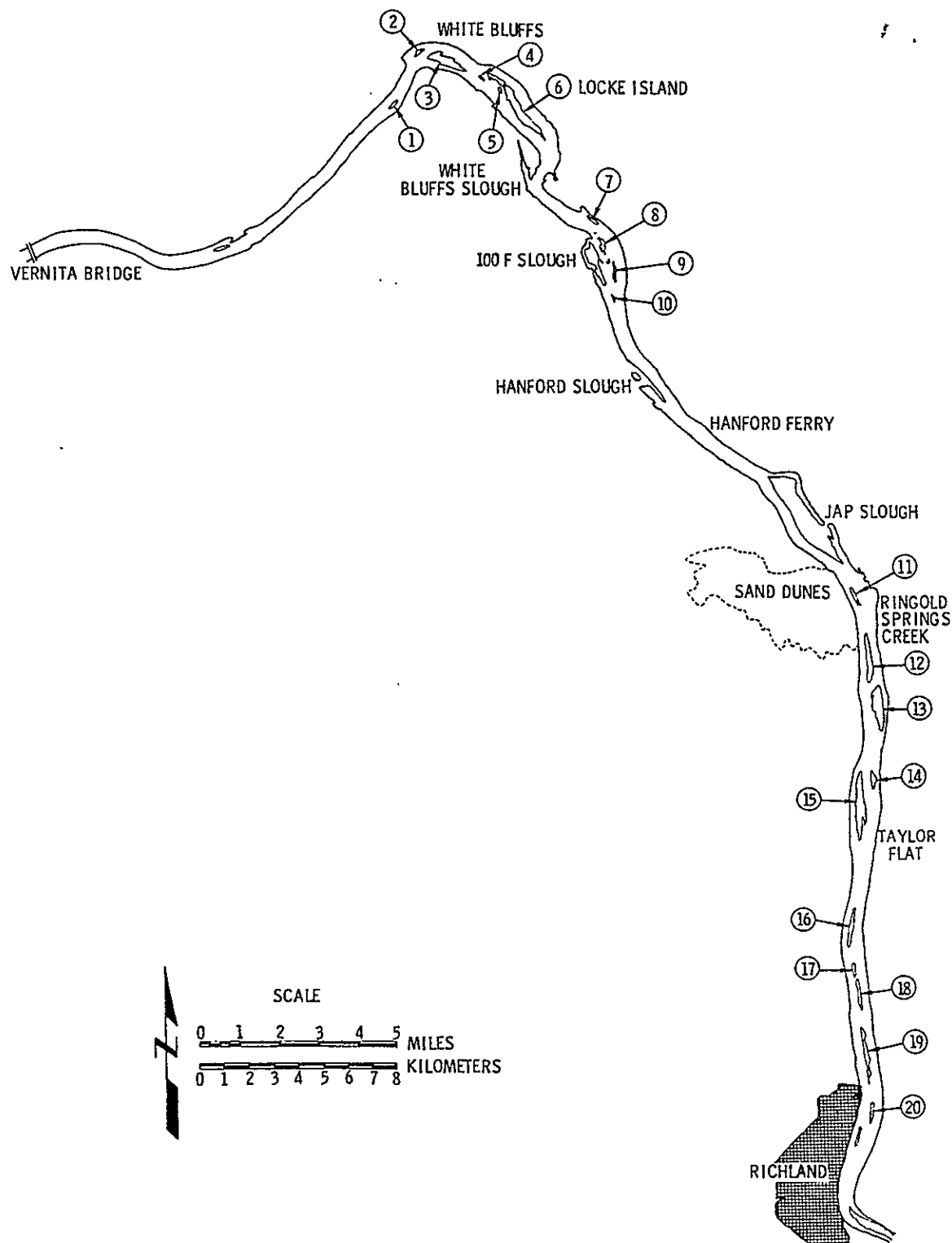


Figure 1. Hanford Reach of the Columbia River showing location of 20 islands used by nesting Canada geese.

This paper summarizes the existing information concerning the non-fisheries biological resources along the Hanford Reach of the Columbia River. Plant names are

derived from Hitchcock and Cronquist (1973), bird names from A.O.U. (1957) and A.O.U. (1973).

### Plant Communities

The plant communities along the Hanford Reach of the Columbia River have not been described in the literature. Daubenmire (1970), in his monograph of the vegetation of interior Washington, provides no description of the plant communities along the Columbia. The most striking feature of Columbia River shoreline plant communities is the paucity of tree corridors, willows and cottonwoods, that characteristically border most streams and rivers. Instead, the streamside vegetation consists of a narrow zone of shrub-willows and various species mixtures of rushes, grasses, and forbs that have the capacity to become established and grow in a rooting substrate consisting mostly of water-worn cobbles and assorted gravels.

Plant community mapping of 20 small islands scattered through the Hanford Reach (done in conjunction with a study of the resident, nesting Canada goose population) has been reported by Hanson and Eberhardt (1971). A team of biologists from the University of Washington mapped the general vegetation patterns along the Hanford Reach as part of a much broader study of the inventory of wildlife along the Columbia River extending from Richland to the Canadian border (U.S. Army Corps of Engineers, 1976).

Although the Hanford Reach of the Columbia River is free-flowing, the historical seasonal and daily pulses of water-level fluctuations have been dramatically altered through storage and release of water for power generation at upstream dams. The streamside vegetation has been changing in response to these water-level fluctuations. Rooting substrates that historically were wetted once a year for a few weeks during the spring flood are now wetted almost daily. There are no baseline reference points or studies specifically established to record the influence of man-induced water fluctuations upon species composition of these streamside plant communities. A summary of the riparian plant communities associated with the Hanford Reach is shown in Table 1.

### Threatened and Endangered Plants

*Astragalus columbianus* has been considered endangered and probably extinct by the United States Fish and Wildlife Service. However, according to Sauer *et al.* (1979), a population of *A. columbianus* occupies non-riparian habitat on benches well elevated above flood stage near Priest Rapids Dam along the western shore of the Columbia River. The population is aggressive, appears to be self-sustaining, and is not in any immediate danger of becoming extinct.

### Avifauna

#### Birds of Prey

Bald Eagles (*Haliaeetus leucocephalus*) regularly use the Hanford Reach during fall and winter months. Employing ground observations and aerial flights, Fitzner and Hanson (1979) showed that the number of wintering Bald Eagles using the Hanford Reach has increased from about 6 birds in the 1960s to 20 birds at the present time. Eagles are attracted to the Columbia River because of salmon carcasses washed ashore from spawning beds scattered along the Hanford Reach (Watson, 1978). Although

TABLE 1. Summary of riparian plant communities associated with the Hanford Reach.

Species	Substrate and water level fluctuations	Location	
Riparian Categories			
I Watercress	permanently wet, little water level fluctuation daily or seasonally	Ringold Spring Creek and Seeps	WET ↑
II Water smartweed speedwell	frequently inundated by fluctuating water level, cobble substrate	narrow zone, all along the river	
III Bulrush, Spike-rush, cattail	frequently wetted by fluctuating water level, cobble substrate or mud	small isolated patches along the river, cattails best developed at Ringold Springs	
IV Reed canary grass barnyard grass goldenrod, sneeze-weed, coreopsis, conyza, sweet clover, begger's tick, sandbar willow, mulberry, cottonwood, Russian olive—others	Periodically wetted by fluctuating water levels, cobble substrate	communities are best developed at Ringold Springs, Taylor Flats, Jap Slough, 100 F Slough, Hanford Slough, White Bluffs Slough	
V Wormweed absinth, sand dropseed shrub eriogonum, lupine	wetted only in annual flood periods, cobble substrate	scattered locations along the river and island shores, 100 D gravel bar, 100 F area	
Non-Riparian Categories			
VI Sagebrush, bitterbrush rabbitbrush, spiny hopsage, cheatgrass sandberg bluegrass, tumble mustard, tansy mustard	soil substrate, not wetted by river fluctuation even at flood stage	lands on the Hanford Site including slopes of the Ringold Bluffs	↓ DRY
VII Scurf pea, pale evening primrose, thick-spike wheatgrass, sanddock	sand dunes not wetted by river fluctuation even at flood stage	sand dunes on the west bank of the river opposite Ringold Springs	
Scientific plant names			
Category I: <i>Rorippa nasturtium-aquaticum</i> Category II: <i>Polygonum amphibium</i> <i>Veronica anagallis-aquatica</i> Category III: <i>Scirpus</i> spp., <i>Eleocharis palustris</i> , <i>Typha latifolia</i> Category IV: <i>Phalaris arundinacea</i> , <i>Echinochloa crusgalli</i> , <i>Solidago</i> sp., <i>Helenium autumnale</i> , <i>Conyza canadensis</i> , <i>Coreopsis atkinsiana</i> , <i>Melilotus officinalis</i> , <i>Bidens</i> sp., <i>Salix exigua</i> , <i>Populus deltoides</i> (?), <i>Eleagnus angustifolia</i> , <i>Morus alba</i> Category V: <i>Artemisia absinthium</i> , <i>Sporobolus cryptandrus</i> , <i>Eriogonum douglasii</i> , <i>Lupinus</i> sp. Category VI: <i>Artemisia tridentata</i> , <i>Purshia tridentata</i> , <i>Chrysothamnus nauseosus</i> , <i>Atriplex spinosa</i> , <i>Bromus tectorum</i> , <i>Poa sandbergii</i> , <i>Sisymbrium altissimum</i> , <i>Descurainia pinnata</i> Category VII: <i>Psoralea lanceolata</i> , <i>Oenothera pallida</i> , <i>Agropyron dasystachyum</i> , <i>Rumex venosus</i>			

salmon carcasses provide an important dietary item, eagles also prey upon disabled waterfowl. Salmon would not spawn here if the water were not flowing fast enough to provide the habitat requirements needed to promote egg hatching and food for juvenile salmon.

The Hanford population of wintering eagles is small compared to wintering populations in western Washington. The Nooksack River population is estimated at 100 birds (Stalmaster *et al.* 1978). In the absence of human harassment, Bald Eagles will probably continue to use the Hanford Reach so long as salmon carcasses remain available as a food source.

The American Osprey (*Pandion haliaetus*) occasionally fishes along the Columbia River, but there are no nesting pairs, possibly because of the lack of suitable nesting trees. Nesting birds of prey have been intensively studied on the Hanford Site (Fitzner *et al.*, 1980). Nests of Swainson's Hawks (*Buteo swainsonii*), Red-tailed Hawks (*Buteo jamaicensis*), Prairie Falcon (*Falco mexicanus*), and American Kestrel (*Falco sparverius*) are located along the Columbia River; however, the food of these birds is mostly of terrestrial origin and shows little alliance to the Columbia River. The Marsh Hawk (*Circus cyaneus*) is present year around and can often be seen flying low along the edge of the river and hovering over riparian plant communities. This hawk also nests on islands in the Columbia River. Great Horned Owls (*Bubo virginianus*) and Common Ravens (*Corvus corax*) occasionally nest on the steep bluffs. Long-eared (*Asio otus*), and Great Horned Owls have been observed nesting in the few scattered trees along the Columbia River, mainly from Hanford ferry crossing upstream for about 10 km on the western shore.

#### Geese and Ducks

The resident Great Basin Canada Goose (*Branta canadensis moffitti*) population on the Hanford Reach has been regularly censused since 1950 (Hanson and Browning, 1959; Hanson and Eberhardt, 1971; Rickard and Sweany, 1977). Nesting has been almost entirely confined to twenty islands scattered throughout the Hanford Reach (Fig. 1), with less than 1 percent of the nests located on the sand and clay cliffs bordering the river on the east. The number of goose nests established on these islands has fluctuated from year to year, but overall there has been a general decline in numbers (Fig. 2). As many as 300 goose nests were present in the early 1950s; however, in 1976 only 77 nests were located on these islands. One of the main reasons for the marked decline in goose nests is predation by coyotes. Predation has occurred from time to time on most of the islands, but resident coyotes have totally discouraged goose nesting on Island 6 (Locke Island), which formerly supported 100 nests (Fig. 2).

The Hanford goose nesting population is the largest along the Columbia River, although there are nesting populations located both upstream and downstream from the Hanford Site. Gibson and Buss (1977) report that the creation of slack water behind a series of dams along the lower Snake River has all but eliminated the nesting population from that section of the Snake River. Nevertheless, a few geese still nest on ledges of steep basalt cliffs along the impoundments. A few Mallards (*Anas platyrhynchos*) also nest along the Columbia River (Hanson and Eberhardt, 1971).

Migrant ducks and geese including Blue (*Chen coarulescens*) and Snow geese (*C. hyperborea*) have historically used the Hanford Reach as a resting stop in fall and winter. They make foraging flights to surrounding fields and rest on the islands and water at other times. During the early years when the river was closed to public use, as many as 250,000 ducks and geese used the river. Since the opening of the river to public boating and recreational hunting from the Hanford townsite downstream to Richland, only about 100,000 waterfowl rest on this section of the river. Major waterfowl concentrations are located immediately above the Hanford townsite in the no hunting area and on lakes and ponds located on the nearby Saddle Mountain Wildlife Refuge. During the late 1950s and early 1960s when reactor effluent waters entered the Columbia River, radioactive phosphorus and radioactive zinc were readily detected

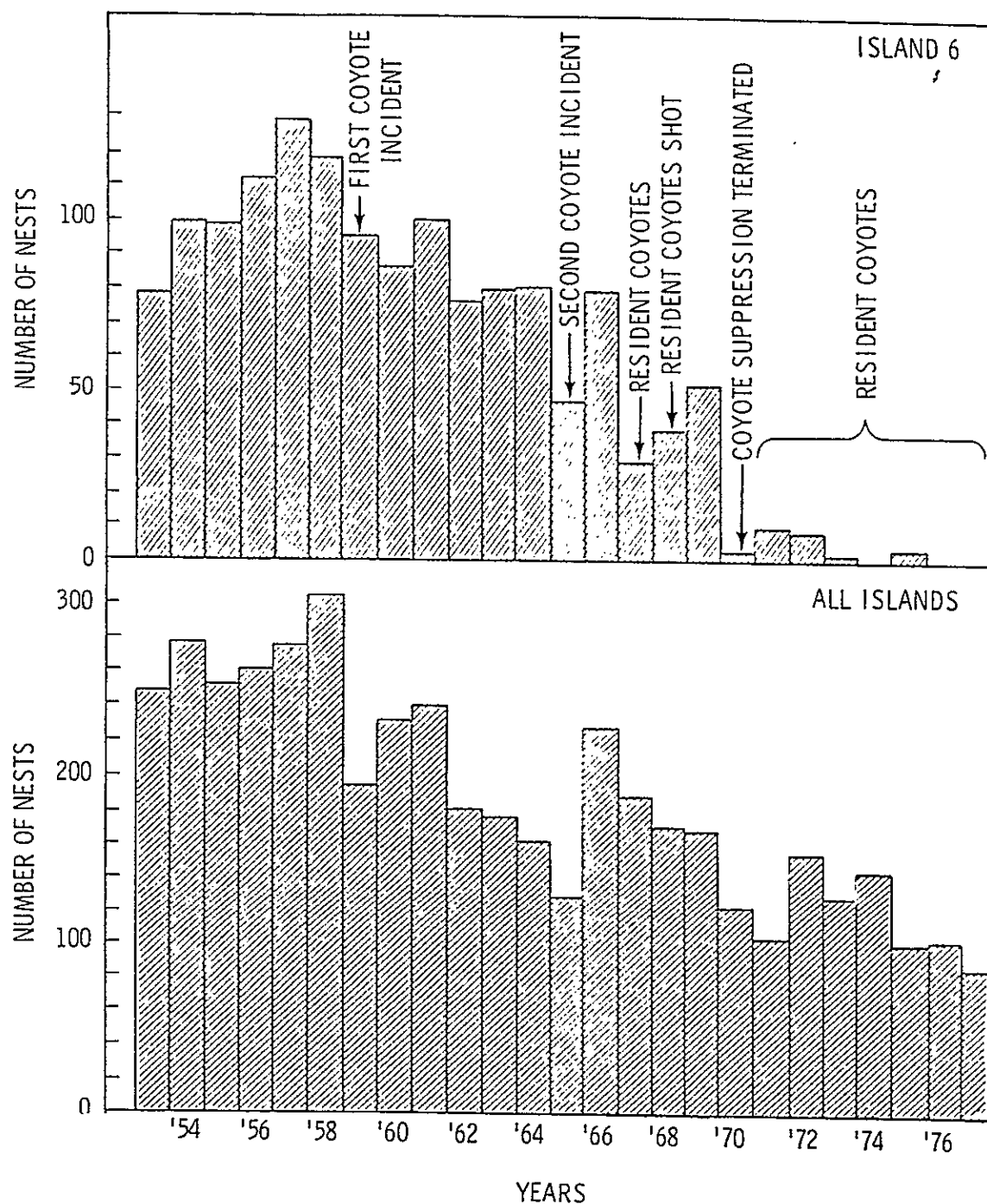


Figure 2. Number of Canada goose nests established on Columbia River islands 1953-1977.

in the bodies of Mallard, Pintail (*A. acuta*), teal, and other ducks that wintered along the Columbia (Hanson and Case, 1963). Since the shutdown of the old style single pass reactors in the late 1960s, there has been no radiophosphorus or radiozinc in the river water even though one production reactor remains operational.

Members of the Lower Columbia Basin Audubon Society regularly census wintering populations of waterfowl along the Columbia River near Richland during the annual Christmas bird counts. Species lists are published in American Birds (1978).

#### Fish-eating Birds

In the 1950s and 1960s Ring-billed (*Larus delawarensis*) and California (*L. californicus*) gulls nested on Island 1 near Coyote Rapids and on Island 12 near Ringold Springs (Hanson, 1963). However, in the early 1970s gulls abandoned these islands, and colonies are now present on Islands 18 and 20 near the city of Richland (Fig. 1). Recent nesting population surveys show that approximately 5250 California gull pairs and 5100 Ring-billed gull pairs nest on the two islands. About 8450 young gulls were banded with Fish and Wildlife Service metal leg bands during the years 1956 through 1970 by W. C. Hanson and associates. Preliminary analyses of band returns indicate that Hanford gulls move westward to the Pacific coast and northward into British Columbia during their first migration flights. Subsequent band recoveries have mostly been reported from the coastal areas of California and Mexico, with scattered reports from inland areas of the western U.S. Forster's terns (*Sterna forsteri*) also nest on Islands 18, 19, and 20 on bare cobblestone substrate close to the waterline. Fluctuations in water level, caused by upstream dams, sometimes inundate nests. We estimate that about 400 pairs of these terns nest along the Hanford Reach of the Columbia River.

A colony of double-crested cormorants (*Phalacrocorax auritus albaclatus*), estimated at 55 to 65 birds, nested on Locke Island during the mid-1950s (Hanson, 1968). This colony was abandoned in 1957 because of the intense competition with Great Blue Herons for nesting sites in a few low-statured mulberry trees. Occasionally a few birds have been seen on the Columbia River between Richland and Ringold Springs in winter. In the years 1950 through 1967, 15 to 20 White Pelicans (*Pelicanus erythrorhynchos*) regularly used the Hanford Reach as a foraging stop in migration. In 1979 the number had dwindled to less than 10. A few American Mergansers (*Mergus merganser*) also nest along the Columbia River. Great Blue and Black-crowned Night (*Nycticorax nycticorax*) herons have nested along the Columbia River for many years. Hanson (1968) noted a small colony on Locke Island that contained 10 to 16 nests of each species during the 1950s. The number of Great Blue Herons using the Columbia River has increased in recent years. At present about 40 pairs nest in a grove of trees near the White Bluffs ferry landing. Nesting colonies are widely scattered in interior Washington probably because of the scarcity of suitable trees. A large mixed colony of about a thousand Great Blue and Black-crowned Night herons has recently become established in peach leaf willow trees (*Salix amygdaloides*) on the northern extremity of the Potholes Reservoir in Grant Co. (Fitzner *et al.*, 1978). Another colony of Great Blue Herons is located on the Umatilla Wildlife Refuge along the Columbia River near Umatilla, Oregon.

#### Upland Game Birds

Small breeding populations of California Quail (*Lophortyx californicus*) and Ring-necked Pheasants (*Phasianus colchicus*) occur along the river, especially in the shrub willows and remnants of abandoned orchards. These birds are not subjected to hunting pressure, but a few birds are killed each year for radiological surveillance purposes (Houston and Blumer, 1979). There are larger pheasant populations associated with the irrigated farmlands surrounding the Hanford Site. Quail populations are much larger in the brushy draws and ravines along the Snake River canyon and in the foothills of the Blue Mountains. Sage Grouse (*Centrocercus urophasianus*) formerly occupied habitats in the southern and western parts of the Hanford Site, gradually disappearing

by the mid-1960s. A few Sage Grouse persist in the Rattlesnake Hills. A single covey of Scaled Quail (*Callipepla squamata*) was noted on the Wahluke slope in 1956. They have not been observed since.

In spring, Mourning Doves (*Zenaida macroura*) nest in the dryland habitats bordering the Columbia River and on the islands. Some doves winter in this area.

#### Shorebirds

The Long-billed Curlew (*Numenius americanus*) nests on the Hanford Site in dry sagebrush vegetation. The nesting birds apparently avoid streamside shrub-grass communities. However, birds that are produced on the Hanford Site congregate on islands in the Columbia just before the onset of autumn migration (Allen, 1980). Another, larger curlew population breeds in sagebrush-grass vegetation near Boardman, Morrow Co., Oregon.

Lists of shorebird species that occur along the Columbia River appear in North American Birds (1978). Although the shorebird habitat is likely to be affected by fluctuating water levels, there has been no consideration of the response of shorebirds to such changes.

#### Other Birds

There have been no studies specifically designed to census the bird populations associated with shoreline tree/shrub communities of the Hanford Reach. However, bird surveys have been conducted in riparian communities with similar plant species composition and general structural appearance on the Hanford Site (Rotenberry *et al.*, 1979) (Table 2) and along the Snake River canyon (Lewke and Buss, 1977). Fitzner and Rickard (1977) surveyed birds in riparian communities associated with waste ponds on the Hanford Site, and winter bird populations have been censused in tree communities along the Yakima River flood plain at Richland, Washington (Rickard and Rickard, 1972). Although similar bird species composition can be expected in Columbia River tree/shrub communities as in other tree/shrub riparian communities, more accurate counts are needed to estimate bird utilization of Columbia River shoreline communities.

#### Mammals

##### Deer

The mule deer (*Odocoileus hemionus*) is the most numerous big game animal on the Hanford Site. The islands and riparian plant communities along the Hanford Reach of the Columbia provide fawning habitat. Current information concerning the known information about Hanford deer has been summarized by Eberhardt *et al.* (1979). Hedlund (1957) reported that mule deer tagged as fawns were hunter-killed at points as far as 110 km from their point of capture (Fig. 3). A few deer are killed each year by automobiles on Hanford Site highways, and samples of tissues are taken for radiological surveillance purposes (Houston and Blumer, 1979).

The existence of the mule deer population at Hanford hinges upon two important factors: first, hunting is not permitted, thus protecting the deer population from seasonal harvest and from poaching mortality; second, the land use of the Hanford Site is non-agricultural, which allows the deer to forage without incurring crop damage claims by land owners, thus encouraging the Washington Game Department to keep the



TABLE 2. Most abundant birds recorded in a riparian tree-shrub community on the Arid Lands Ecology Reserve. (Modified from Rotenberry et al., 1979).

Breeding birds		Wintering birds	
Mourning Dove	28.5 (11)	Dark-eyed Junco	26.5 (9)
<i>Zenaidura macroura</i>		<i>Junco hyemalis</i>	
Chukar	20.7 (7)	Yellow-rumped Warbler	4.7 (2)
<i>Alectoris chukar</i>		<i>Dendroica coronata</i>	
Western Meadowlark	19.4 (11)	Western Meadowlark	3.7 (5)
<i>Sturnella neglecta</i>		<i>Sturnella neglecta</i>	
Barn Swallow	8.9 (11)	American Robin	2.6 (6)
<i>Hirundo rustica</i>		<i>Turdus migratorius</i>	
Northern Oriole	7.6 (10)	Black-billed Magpie	2.2 (8)
<i>Icterus galbula</i>		<i>Pica pica</i>	
Vesper Sparrow	7.4 (7)	White-crowned Sparrow	1.8 (5)
<i>Poocetes gramineus</i>		<i>Zonotrichia leucophrys</i>	
Starling	5.6 (5)	Ring-necked Pheasant	1.7 (5)
<i>Sturnus vulgaris</i>		<i>Phasianus colchicus</i>	
Lazuli Bunting	5.5 (10)	Song Sparrow	1.6 (7)
<i>Passerina amoena</i>		<i>Melospiza melodia</i>	
Black-billed Magpie	5.2 (10)	California Quail	1.5 (1)
<i>Pica pica</i>		<i>Lophortyx californicus</i>	
Wilson's Warbler	3.7 (4)	Ruby-crowned Kinglet	1.2 (6)
<i>Wilsonia pusilla</i>		<i>Regulus calendula</i>	
Brewers' Blackbird	2.8 (6)	20 Other species	10.2
<i>Euphagus cyanocephalus</i>		The tree-shrub community consists of a narrow corridor of cottonwood and willow trees about 1.5 km long and usually less than 30 meters across. Other species: Golden Eagle, Red-tailed Hawk, Goshawk, Cooper's Hawk, Rough-legged Hawk, Swainson's Hawk, Pigeon Hawk, Long-eared Owl, Common Raven, Loggerhead Shrike, Northern Shrike, Killdeer, Red-winged Blackbird, Tree Swallow, Night Hawk, Black-headed Grosbeak, Vesper Sparrow, Savannah Sparrow, Lark Sparrow, Rufous-sided Towhee, Sage Sparrow, Golden-crowned Sparrow, Slate-colored Junco, Western Kingbird, Say's Phoebe, Trails' Flycatcher, Western Wood Pewee, Dusky Flycatcher, Rock Wren, Canyon Wren, Winter Wren, House Wren, Long-billed Marsh Wren, Red-shafted Flicker, Golden-crowned Kinglet, Red-eyed Vireo, Warbling Vireo, Solitary Vireo, Nashville Warbler, Yellow Warbler, Townsend's Warbler, McGillray's Warbler, Varied Thrush, Hermit Thrush, Townsend Solitaire, Rufous Hummingbird.	
Eastern Kingbird	1.9 (5)		
<i>Tyrannus tyrannus</i>			
California Quail	1.8 (6)		
<i>Lophortyx californicus</i>			
Western Tanager	1.5 (5)		
<i>Piranga ludoviciana</i>			
Song Sparrow	1.4 (7)		
<i>Melospiza melodia</i>			
Sage Grouse	1.4 (2)		
<i>Centrocercus urophasianus</i>			
Yellow-breasted Chat	1.1 (6)		
<i>Icteria virens</i>			
Brown-headed Cowbird	1.1 (3)		
<i>Molothrus ater</i>			
White-crowned Sparrow	1.0 (1)		
<i>Zonotrichia leucophrys</i>			
American Kestrel	1.0 (7)		
<i>Falco sparverius</i>			
Rock Wren	1.0 (7)		
<i>Salpinctes vulgaris</i>			
38 Other species	12.1		

Values are average number of individuals seen in 11 breeding seasons (May-August) and in 10 wintering seasons (November-March) counts. Actual count in which each species was observed is in parentheses.

herd size as small as practical. The Hanford mule deer population is isolated from larger deer populations in the Blue Mountains to the east, the Cascade Mountains to the west, and from the Snake River canyon population by many miles of intervening farmland. A few mule deer reside in the Rattlesnake Hills, but no one knows whether this small population is isolated from the larger deer population along the Columbia River.

The mule deer herd on the Hanford Site may not be as healthy as other populations. Steigers (1978) stated that the daily movements of radiotelemetered fawns on the Hanford Site were greater than those of fawns at other locations. This finding may be an indication that parent deer have to travel farther to obtain their daily dietary

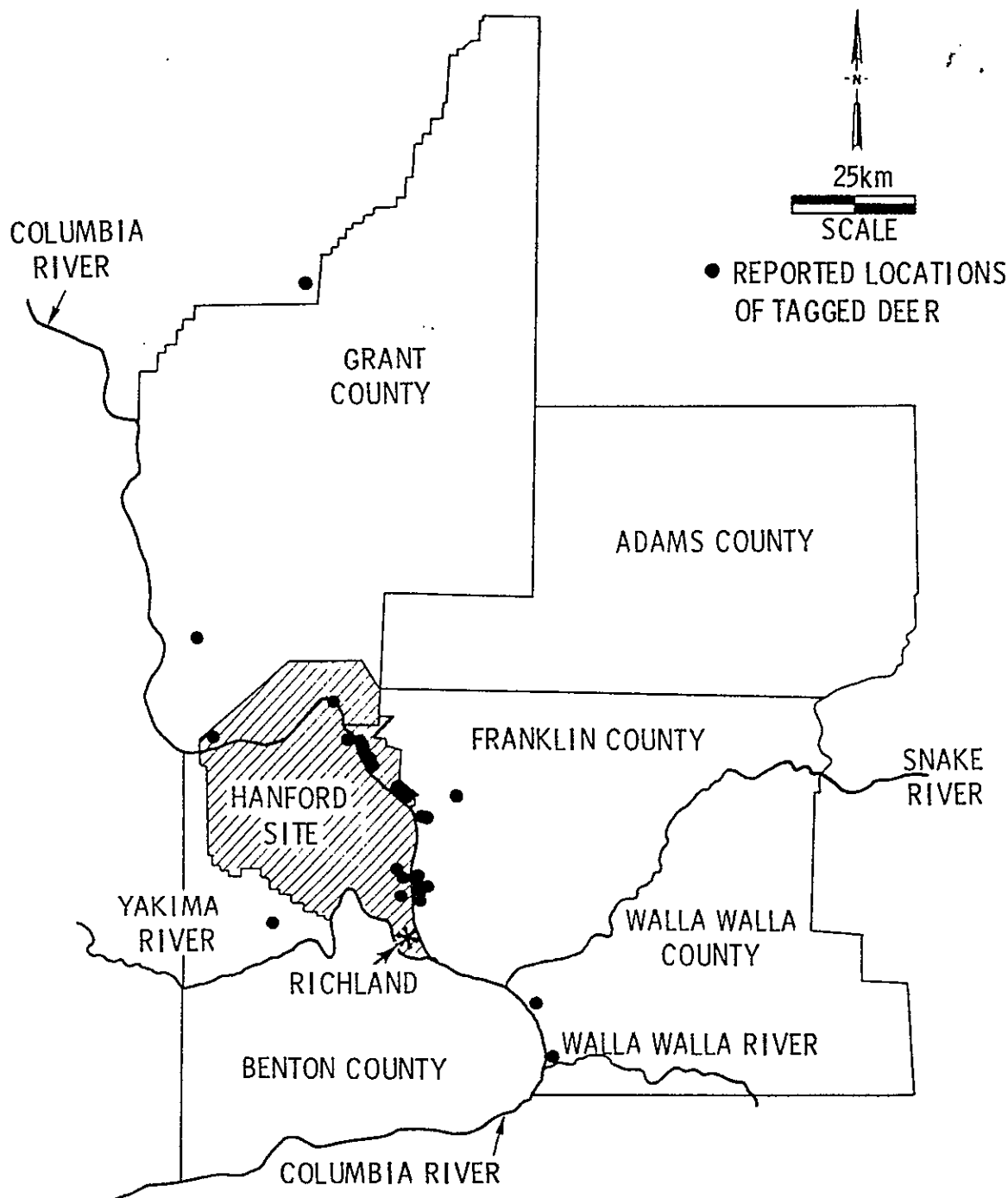


Figure 3. Recovery locations of mule deer tagged on the Hanford Site.

requirements. Eberhardt *et al.* (1979) examined six years of fawn tagging records from the Hanford Site. These data showed a decline in the number of fawns tagged in the last three years of record, suggesting that fewer fawns were being produced. Perhaps there are fewer females to produce fawns, or fawn predation has become more pronounced, or fawning occurs elsewhere. Tagging was conducted primarily on islands, and this may have disturbed the deer; as a result, fawning may have moved inland.

Apparently summer browse plants on the Hanford Site are scarce, and the few

available trees are being utilized to their maximum. Inadequate summer browse might contribute to a decline in the general health and productivity of a deer population. However, there is no information concerning total numbers, sex ratios, average weights, or age distribution of the Hanford mule deer herd.

The most conspicuous plants along the Hanford Reach of the Columbia River are a few aged trees (shade and ornamentals) planted around farmsteads in the years prior to 1943. These are mostly Chinese elm (*Ulmus* sp.), black locust (*Robinia pseudacacia*), lombardy poplar (*Populus* sp.), white poplar (*Populus alba*), eastern cottonwood (*Populus* sp.), and mulberry (*Morus* sp.). At a few places some fruit trees still survive, especially apricots. Over the years some of these trees have died and have been uprooted or broken by strong winds.

Mulberry, Russian olive, cottonwood, and peach-leaf willow are aggressive enough to establish seedlings at favorable microsites in the riparian zone (Fig. 4). Tree foliage



Figure 4. Trees self-established in the riparian zone.

provides a forage source for mule deer and porcupine (*Erethizon dorsatum*). Mule deer eat leaves hanging within their reach. Trees provide pools of shade which are actively sought by mule deer during the hot, sunny summer months. Nearly all of the trees along the western bank of the Columbia River show browse-lines by deer (Fig. 5). Since most of the deer population is confined to the western shore under the protective umbrella provided by the Hanford Site, volunteer mulberry trees on the western shore are severely pruned by mule deer while those on the opposite shore remain relatively untouched. Occasionally a white-tailed deer (*Odocoileus virginianus*) is observed on the Hanford Site (O'Farrell and Hedlund, 1972).

#### Furbearers

Coyotes (*Canis latrans*) are important predators of mule deer fawns on the Hanford Site (Steigers, 1977). Although the Columbia River is not an impossible barrier to coyote movement, radiotracking studies showed that tagged coyotes spent a great deal of their time within a distance of a few kilometers of the river (Springer, 1977). The coyote population is probably greater on the Hanford Site than on the surrounding farmlands. About 700 coyotes were removed from Hanford and surrounding environs each year during the period 1950 to 1970 by the U.S. Fish and Wildlife Service (Hanson and Eberhardt, 1971). Coyote trapping is practiced as a source of income and as a recreational endeavor around the periphery of the Hanford Site.

Beaver (*Castor canadensis*), muskrat (*Ondatra zibethica*), and mink (*Mustela vison*) occur along the Columbia River. There is no estimate of their abundance. The most suitable slack water habitats are in the vicinity of Ringold Springs, Jap slough, Hanford slough, 100F slough, and White Bluff slough (Fig. 1). Other furbearing



Figure 5. Trees showing browse lines created by mule deer.

mammals that occur along the river but for which there is no specific information are raccoon (*Procyon lotor*), skunk (*Mephitis mephitis*), weasels (*Mustela frenata* and *M. erminea*), and bobcat (*Lynx rufus*).

#### Small Mammals

Small mammals undoubtedly occur in the riparian plant communities along the shore of the Columbia River, although there have been no specific studies made on species composition or relative abundance. Deer mice (*Peromyscus maniculatus*), house mice (*Mus musculus*), vagrant shrew (*Sorex vagrans*), and montane meadow mouse (*Microtus montanus*) are present. The Columbia River is well known as a barrier to the dispersal of Ord's kangaroo rat (*Dipodomys ordii*) and the Washington ground squirrel (*Spermophilus washingtoni*): both of these species occur on the east bank of the river but not on the west bank. Preliminary data indicate that some of the islands do harbor these species. Bushytail woodrats (*Neotoma cinerea*) occur in abandoned buildings and in trees planted by homesteaders.

#### Hares and Rabbits

Black-tailed hares (*Lepus californicus*) occur throughout the undeveloped sagebrush-grass vegetation along the Columbia River, but these animals are not dependent upon riparian vegetation for their existence. However, cottontails (*Sylvilagus nuttallii*) seem to prefer edge habitats where riparian tree/shrub communities adjoin sagebrush-grass communities. There have been no studies made to estimate the abundance of cottontails along the Hanford Reach.

### Ecological Relationships

#### Prey/Predator Relationships

Coyotes have been instrumental in the observed decline in the nesting Canada Goose population. Coyotes destroy nests, occasionally kill adult geese, and have made Locke Island unacceptable for nesting. Coyotes are also an important cause of mule deer fawn mortality and also contribute to destruction of nests of the Long-billed Curlew (Fitzner, 1978). The coyote is an extremely versatile predator. A few individuals have learned to capture live fish, mostly carp, trapped in shallow pools along the shoreline of the Columbia (Springer, 1980).

The Great Blue Heron colony at White Bluffs depends upon fish as a food source during the nesting season. Trash fish, carp and suckers, are probably the most important food items. The Bald Eagles depend primarily upon the annual run of anadromous fish to provide winter food in the form of salmon carcasses.

Large numbers of Cliff (*Petrochelidon pyrrhonata*) and Bank swallows (*Riparia riparia*) nest on the steep cliffs bordering the east bank of the river. These birds catch flying aquatic insects, especially caddis flies, that emerge from the riffle substrates of the Columbia River in large numbers in spring and summer months. Some swallows, adult and young, are the prey of Prairie Falcons and American Kestrels that nest on shelves and in cavities on the same cliffs.

#### Food Chains and Chemical Contamination

High trophic level animals characteristically have low population densities and also have low reproductive potential. Populations of some of these animals, particularly

raptorial birds such as the Bald Eagle and Peregrine Falcon, have declined to the extent that they are regarded as "endangered" or "threatened." Because high trophic level animals are often wary and are not abundant, ways other than killing need to be devised to determine whether chemical contaminants are transmitted to them through their diets. Rickard *et al.* (1977) collected detritus cast from heron nests as an indicator of radionuclide contamination in heron foods. Springer (1977) collected coyote scats from various parts of the Hanford Site as indicators of radionuclides in coyote foods. Fitzner *et al.* (1980) collected the regurgitated pellets from nest sites and roosts of hawks and owls on the Hanford Site. Radiochemical analyses of these pellets indicated that some of these birds had access to prey items containing radionuclides of Hanford origin. The use of fecal materials and castings appears to be a useful way to monitor high trophic level animals in order to detect buildups of persistent chemicals in their environments. This method of monitoring would be especially useful in pristine and other environments that maintain enough of their essential ingredients to support populations of high trophic level animals.

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